

CIVIL DEFENCE

A PRACTICAL MANUAL PRESENTING WITH
WORKING DRAWINGS THE METHODS RE-
QUIRED FOR ADEQUATE PROTECTION
AGAINST AERIAL ATTACK

BY

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EXTRACTS

Note: on page 11, Glover
estimates that the "first line
strengths" for air power in
March 1937 were Germany = 3,500
and British Home Defence = 1,750
aircraft.



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PREFACE

THE ineradicable instinct of self-preservation in man prompts him to clutch at any straw in a vital emergency.

Experience in war has shown that even the resourceful serving soldier all too often exhibits peculiar ideas of what constitutes adequate protection and shelters constructed without the exercise of the fundamental principles of structural stability have proved themselves to be the greater danger.

Yet the mere act of occupying them has contributed in no small measure to the maintenance of mental equilibrium in the stress of many a bombardment.

In the presentation of this volume, attempts have been made to analyse the problems confronting modern society for the adequate protection of the civil population, and it is confidently hoped that its appearance will not be taken as an acceptance of the inevitability of war, but rather as a means of focussing national attention to the moral necessity for the prompt preparation of civil defence.

The author feels it incumbent upon himself to make his position quite clear at the outset.

He has considerable sympathy with the sentiments of the idealist but is forced by consideration of the facts of the present position to abandon utopian ideas and come out in the open definitely a realist.

He is not an alarmist nor an ultra-pacifist and has endeavoured to present and examine the facts fairly and without political bias in the fervent hope that Civilian Defence in all its aspects will be taken up seriously by the nation. The civilian population trained to protect itself will be largely insured against injury and panic and thus the great cities of this country—at present almost an invitation to the air raider—will not present tactical advantages worth the military effort and risk in securing them.

The appalling increase in the offensive power and suddenness of aerial attack makes even the hasty improvisation of defence

	FIG. NOS.
Messrs. Richard Costain Ltd.	77
Messrs. Kontragas Ltd.	78, 79
Messrs. Conjoint Constructors Ltd.	80
Messrs. Nissen Buildings Ltd.	86, 87

The author also wishes gratefully to acknowledge his indebtedness to officials of the Home Office for much valuable help and criticism in the preparation of the work.

Views expressed are solely those of the author and are in no sense official.

Chapters are addressed to the layman as well as the architect and builder, and it is hoped that the details, working drawings and suggestions herein contained will assist forward the humanitarian work of the protection of the defenceless citizen.

C. W. G.

July 7th, 1938.



Inventor and author Captain C. W. Glover, explaining to Pathe news reel his new plan for London's Air Port Of The Future, 1933

SOURCE: <http://www.britishpathe.com/video/the-air-port-of-the-future-aka-airport-of-future>

CHAPTER I

PROBABLE FORMS OF AERIAL ATTACK

It is obviously not possible to predict the exact form which aerial attack in the future would take, but there is no doubt that the element of surprise and the demoralising effect of the swift use of overwhelming force would be tactical advantages which would be seized by an enemy.

A study of the statistical summary of raids on the administrative County of London during the Great War indicates the tactics then adopted.⁶⁵ (See Table I, p. 9.)

The attempts to "set fire to London" from the air persistently carried out in the raids during 1915-17 failed, largely because of the low efficiency of the incendiary bombs then used, the bad marksmanship of the bomber and the brilliantly effective fire fighting services employed by the London Fire Brigade. Out of 354 incendiary bombs on London only eight caused fatal casualties and seven other injuries.

The maximum number of incendiary bombs which fell in London during one raid was 258 and these were distributed over a wide area averaging seven bombs per square mile.

There is no reason why a ruthless and untiring enemy zone bombing from a great altitude should not be able to increase this concentration a hundredfold, using incendiary bombs each many times more effective.

The increased use of high explosive bombs brought about a corresponding increase in casualties and material damage—an effect also observed in Paris. Out of 567 explosive bombs on London, 144 caused fatal casualties and 74 other injuries.

The total number of casualties in England from aerial attack during the Great War were 1,414 killed and 3,416 wounded; material damage £3,000,000, produced by 643 aircraft, which dropped in all 8,776 bombs weighing about 270 tons in the aggregate. About two-thirds was concentrated upon London.

In Germany the number killed by allied air raids is said to

Piecemeal spasmodic efforts in a task of such dimensions are bound to be ineffective ; and the avoidance of promiscuous large-scale national expenditure on protective construction can

TABLE I
STATISTICAL SUMMARY OF RAIDS ON THE ADMINISTRATIVE
COUNTY OF LONDON DURING THE GREAT WAR.

Date.	Time.	Weather.	Raiders.	Bombs dropped		Killed.	Injured.	Fires.	Damage.
				Incen- diary.	Explo- sive.				
31/5/15	Night	Fine moon	1 Zep. L.Z.38	87	25	7	32	41	£18,396
17/8/15	"	Clear	" L.10	40	20	10	48	21	5,000
7/9/15	"	Mist	{ Zep. L.Z.74 Ship SL.2 }	27	18	18	38	8	7,809
8/9/15	"	Clear	Zep. L.13	45	13	22	87	29	530,787
13/10/15	"	Clear, slight N. wind	{ Zep. L.13 " L.15 }	39	24	38	87	13	50,250
24/8/16	"	Rain	Zep. L. 31	8	36	9	40	6	130,000
23/9/16	"	Misty	{ Zep. L. 31 " L.33 }	46	27	26	73	30	64,662
28/11/16	Day	Sunny	1 aeroplane	—	5	1	1	—	510
13/6/17	"	"	14 Gothas	—	92	145	382	5	125,953
7/7/17	"	"	21 "	—	64	53	182	7	203,821
4/9/17	Night	Cloudy	9 "	—	40	14	48	—	31,548
24/9/17	"	Clear	3 "	16	13	14	49	2	24,002
25/9/17	"	"	3 "	19	7	6	21	1	16,101
29/9/17	"	"	4 "	—	24	13	86	—	21,873
30/9/17	"	"	8 "	2	12	3	29	1	7,600
1/10/17	"	"	8 "	—	28	11	41	1	44,094
19/10/17	"	Fog	Zep. L.45	—	3	33	49	1	48,205
1/11/17	"	Drizzle	3 Gothas	17	21	6	5	4	7,443
6/12/17	"	Just be- fore day- break— clear	6	258	9	3	15	52	92,477
18/12/17	"	Cloudy	7 "	47	42	13	79	13	225,016
28/1/18	"	Misty	3 Gothas, 1 Giant	—	44	65	159	4	172,677
16/2/18	"	Cloudy	1 Giant	—	3	12	6	—	18,229
17/2/18	"	"	1 "	—	19	21	32	2	38,898
7/3/18	"	E. wind	3 Giants	—	9	22	29	1	30,530
19/5/18	"	Fog	19 Gothas and Giants.	—	46	39	128	3	130,733
25 Raids				651	644	614	1,746	245	£2,046,614

TABLE IX

PROTECTION AGAINST PERFORATION AND EXPLOSION

Weight of Bomb	Concrete, 5,690 lbs. at 28 days specially reinforced.	Limestone rock or reinforced Concrete (3,130 lb. grade).	Concrete, not reinforced (2,150 lb. per sq. in. at 28 days)	Constructions in Tunnel.		
				Soft Rock.	Compressed Gravel.	Earthy Sand.
50	2' 4"	4' 3"	4' 7"	11' 6"	18' 1"	21' 4"
100	3' 7"	5' 7"	6' 11"	16' 5"	24' 7"	29' 7"
300	4' 7"	6' 11"	9' 2"	24' 7"	36' 1"	42' 8"

It has been estimated that the blast from a 500 lb. H.E. bomb causes an instantaneous increase in atmospheric pressure equivalent to about 200 times that produced by normal wind pressure, say 6,000 lb. per sq. ft. 50 ft. from the burst.

This, however, lasts for but three ten-thousandths of a second and the reaction immediately following results in a pull in the opposite direction. Windows in buildings are often blown outwards due to this effect by the bursting of a bomb in the street.

The whole time taken for blast pressure to act and die away is approximately $\frac{1}{1000}$ th of a second, and if the pressure were maintained there are but a few walls in existence that could safely withstand them.

Investigations tend to show, however, that buildings of normal strong construction will not be seriously affected by the blast of 500 lb. high explosive bombs bursting 50 ft. or more away (see Chapters on Shelters).

According to an official Swiss formula the blast pressure at any distance from a high explosive bomb explosion can be calculated as below :

$$P = \frac{248Q}{R^2} \text{ lb. per sq. in.}$$

where Q is the weight of explosive in lb. and R is the distance from the explosion in feet.

In light doors, windows and partitions the stabilising effect of the inertia to resist this instantaneous pressure must be neglected, but in heavy massive construction this effect is appreciable.

CHAPTER III

GAS BOMBS AND THEIR EFFECTS

“ GAS ” to the layman holds unknown terrors, but thanks to the advance of science it is no longer the most deadly weapon in the hands of a potential enemy.

The total number of compounds known to chemical science is estimated at nearly half a million, and about a quarter of a million have been carefully studied and their various effects recorded.

Nearly all chemical substances exert some toxic influences, but during the World War about 300,000 substances were investigated with a view to their use in combat.

Of about thirty found suitable for use only twelve were finally adopted, the elimination being due to the stringent technical and tactical requirements imposed.

Only about six compounds were notably successful, and the following extract from statistical summaries is of interest.

125,000 tons of battle gases were used by the seven principal countries engaged in the World War (all theatres), the approximate allocation being as below :—

TABLE XI

	Tons.	Lbs. of gas per casualty
Lung injurants . . .	100,500	230
Vesicants	12,000	60
Sternutators	6,500	650
Lacrimators	6,000	0
Total	125,000	192 av.

The total gas casualties were 1,296,853, or one for each 192 lb. of gas.

TABLE XII

Quantity.	Form of Agent.	Casualties.	Rate per Casualty.
5,000,000,000 lb. .	High explosive . .	10,000,000	500 lb.
1,389,000,000 rounds.	Non-gas	13,356,435	104 rounds
50,000,000,000 rounds.	Small arms ammunition	10,000,000	5,000 rounds
1,200 tons .	} Mustard gas shell .	400,000	{ 60 lb.
9,000,000 rounds.			{ 22.5 rounds

Mustard-gas shell proved to be twice as effective as the average gas shell and nearly five times as effective as explosive shells.

The mobilised forces engaged in the World War aggregated 68,321,638, 54.7 per cent. of which became casualties. Although gas caused 4.6 per cent. of all battle injuries and 5.7 per cent. of all non-fatal battle injuries, it caused only 1.32 per cent. of all battle deaths.

Gas was therefore over four times as effective in causing non-fatal casualties as in causing battle deaths.

Modern warfare does not take the form of annihilation of the forces in the field so much as the paralysis of the economic resistance of the nations engaged.

Chemical warfare being most effective in producing non-fatal casualties, which are a military liability, is likely therefore to be adopted to an increased extent in future wars. Indeed it is now clear from the plans of the belligerents in the World War that had this continued for another year the campaign in 1919 would have been largely a chemical war.⁷⁴

Among the gassed the sufferings are less severe and of shorter duration than those caused by other battle injuries, and statistics show that on the whole recovery from gas incapacitation occupied about half the duration of hospital treatment required in other cases of wounding.

The ratio of deaths to total casualties in non-gas cases was over twelve times that of the mortality from gas.

Gas warfare is therefore most effective and humane, and must be expected to play an important part in future wars.

It is a common misconception that there are some gases suitable for use in chemical warfare and which are incapable of neutralisation or filtration by any known means.

“Those well qualified to speak on the subject, notably

Professor Haldane, have adduced a number of scientific reasons for disbelieving in the existence of such gases, and also in the likelihood of their being produced by future research. The explanation is simple. The number of volatile chemical substances is limited, and of these only a small proportion are poisonous. Those with a small molecular weight are on the whole the most volatile, *i.e.*, go most easily into vapour. *But they are all of relatively simple chemical composition, and the larger majority are already known.* Any fears on this ground are therefore practically negligible. With regard to the substances of high molecular weight, it is certainly possible that some may yet be discovered to give off vapours more poisonous than any known gas to-day. But, on the authority of Professor Haldane, *the charcoal in the ordinary respirator has the property of adsorbing heavy molecules of vapour quite independently of their chemical composition.* And what, it may be asked, of gases like carbon monoxide and hydrogen arsenide which attack and kill without causing odour or irritation? Again the explanation is simple. Such gases may prove fatal if encountered in the laboratory or factory; but in the concentrations required to kill by an attacking force they could not practically be produced in the open.”⁶⁶

Gas attacks on a civil population can be rendered practically harmless by the equipment and organisation of the community properly to combat them.

The underlying principles of chemical warfare can be traced to ancient times when “Greek Fire,” reputed to be compounded of sulphur, spirits of wine, pitch, salt, olive oil and resin, was used in the eighth century B.C.

In 1811 the systematic use of sulphurous fumes and carbon smoke as an offensive weapon was proposed by Lord Cochrane, but it was not until 1915 in the Great War that noxious and toxic gases were effectively employed as a belligerent weapon.

Brief particulars of gases now used in war are tabulated on p. 37 :—

There are two main types of poison gas which might be used, namely :—

(1) Persistent.

(2) Non-persistent.

Persistent gases usually consist of liquids (*e.g.*, mustard gas)

TABLE XIII
POISONOUS GASES

Substance.	Chemical formula.	Date of introduction.	Boiling-point, degrees centigrade.	Approximate concentration to incapacitate a man in a few seconds owing to lachrymation or coughing.	Approximate concentration which if breathed for more than one or two minutes would cause actual damage to the lungs.	Gas concentration which will prove fatal if breathed for half an hour. Milligrams per metre cube.
LUNG INJURANTS						
Chlorine .	Cl_2	1915	- 33.6	1 : 10,000	> 1 : 10,000	250
Phosgene .	COCl_2	1915	+ 8.2	1 : 100,000	1 : 50,000	15
Trichloromethylchloroformate .	Cl.COO.CCl_3	1916	+ 128	1 : 200,000	1 : 50,000	17
Chloropicrin	CCl_3NO_2	1916	+ 112	1 : 200,000	1 : 50,000 (Cumulative)	70
LACHRYMATORS (ACTION ON EYES)						
Xylol bromide	$\text{CH}_3\text{C}_6\text{H}_4\text{CH}_2\text{Br}$	1915	+ 218	1 : 2,000,000	—	
Ethyl iodoacetate .	$\text{CH}_3\text{ICOOC}_2\text{H}_5$	1916	+ 180	1 : 5,000,000	1 : 50,000	
PARALYSANTS (ACTION ON NERVOUS SYSTEM)						
Hydrocyanic acid .	HCN	1916	+ 26.5	> 1 : 2,000 (immediately fatal).	No cumulative action.	15
(SENSORY IRRITANTS OF EYES, NOSE AND CHEST (STERNUTATORS))						
Diphenylchlorarsine	$(\text{C}_6\text{H}_5)_2\text{AsCl}$	1917	+ 383 (M.P. 43)	< 1 : 10,000,000	1 : 50,000	
Diphenylcyarsine.	$(\text{C}_6\text{H}_5)_2\text{AsCN}$	1918	> + 350 (M.P. 31)	< 1 : 10,000,000	1 : 50,000	130
Ethyl dichlorarsine	$\text{C}_2\text{H}_5\text{AsCl}_2$	1918	+ 156	1 : 500,000	1 : 20,000	
VESICANTS (EVAPORATION IS SLOW AND ACTION IS THEREFORE "PERSISTENT")						
Dichlorethylsulphide (Mustard gas)	$(\text{CH}_2\text{ClCH}_2)_2\text{S}$	1917	+ 217 (M.P. + 14)	—	1 : 100,000 (with 60 min. exposure).	50

which contaminate the area on which they are released, and may continue to give off vapour for hours, days, or even weeks, if not neutralised.

Non-persistent gases, when released, rapidly mix with the atmosphere and disperse quickly.

War gases must have an injurious effect in low concentrations, must be heavier than air and capable of a wide distribution.

They may be released on civil populations from gas bombs or by spray from aeroplanes in liquid form, or irritant smokes.

Persistent gases of the mustard type are most dangerous when released as spray, as the drops of condensed "gas" may remain unsuspected on objects which may come into contact with the human body.



FIG. 25.

On December 11th, 1915, the Germans first used the deadly phosgene gas. The British Intelligence Service obtained five months' notice, and also ascertained the sector in which this would be employed. The attack was successfully met by the timely issue of a modified form of P.H. helmet which had two eye-pieces and an outlet valve of rubber. It was impregnated with caustic soda, phenol and glycerine, producing sodium phenolate, which neutralised the phosgene. It was known as the P. helmet.

To meet the increasing concentrations of gas in 1916 the British box respirator was introduced. This had a canister filter carried in the haversack connected with a rubber pipe to a mouthpiece. A nose-clip prevented breathing through the nose and close-fitting goggles inside the face-piece were used to protect the eyes against lacrimators.

With but small improvement this mask served the British till the end of the war.

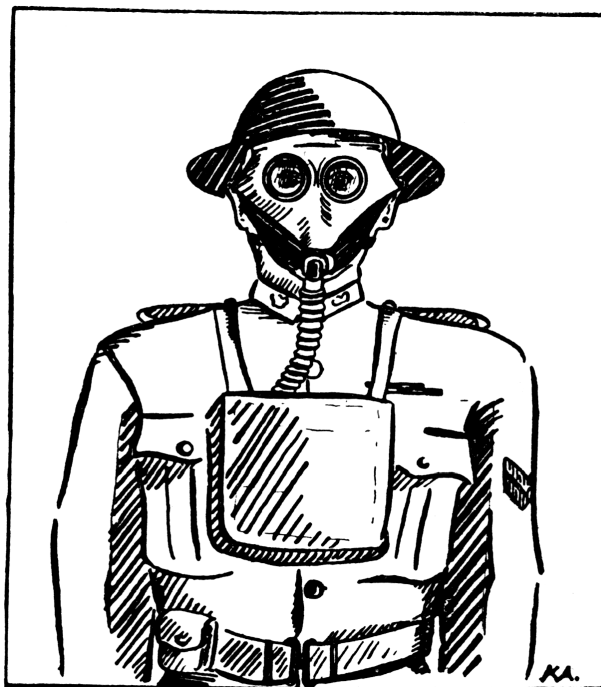


FIG. 25.



FIG. 40.—The general Civilian Respirator, 30 millions of which have been manufactured and stored officially for local issue in an emergency.

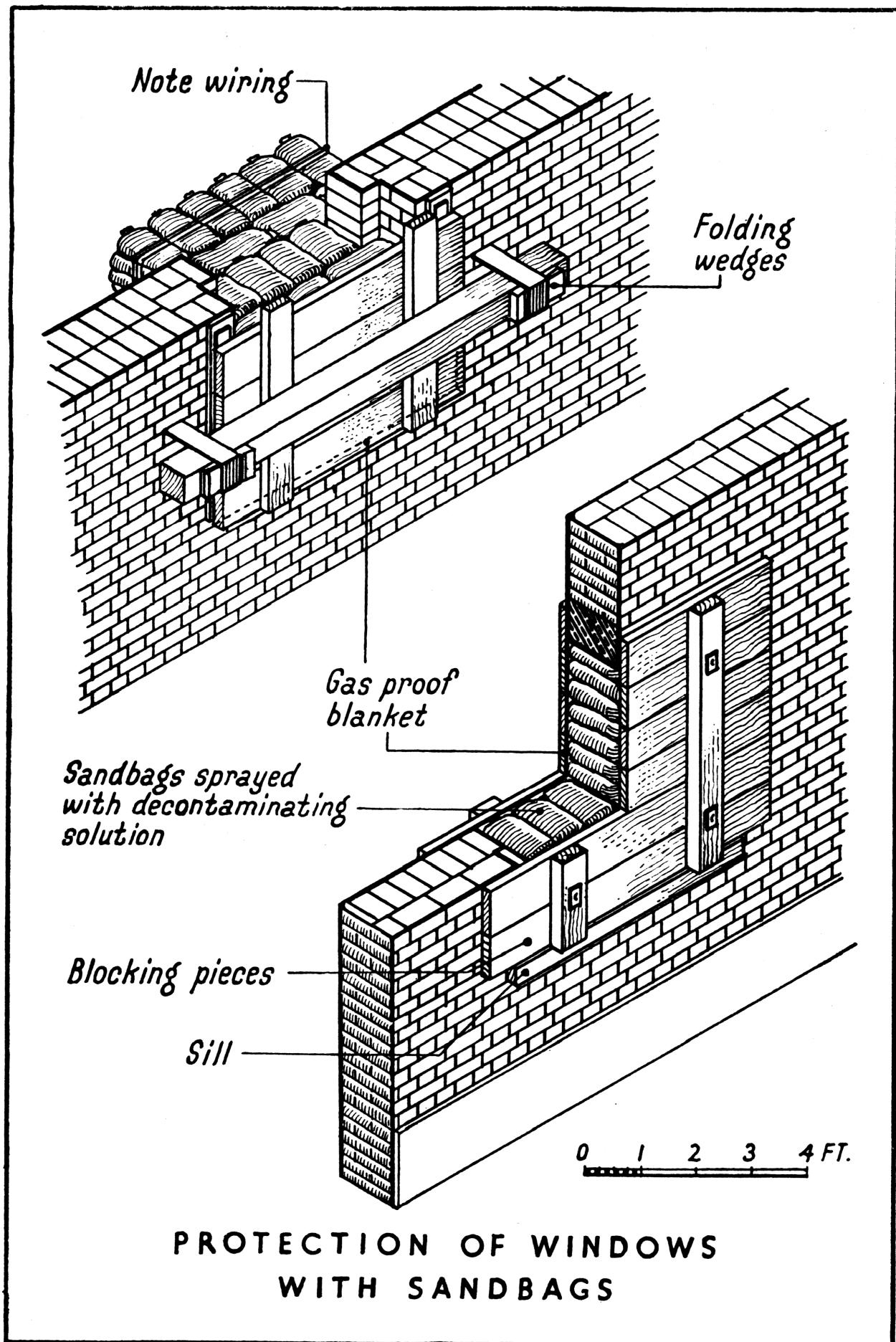


FIG. 46.—Protection of window opening with sand-bags.



FIG. 62.—Norcon tubular shelter (emergency exit not shown).

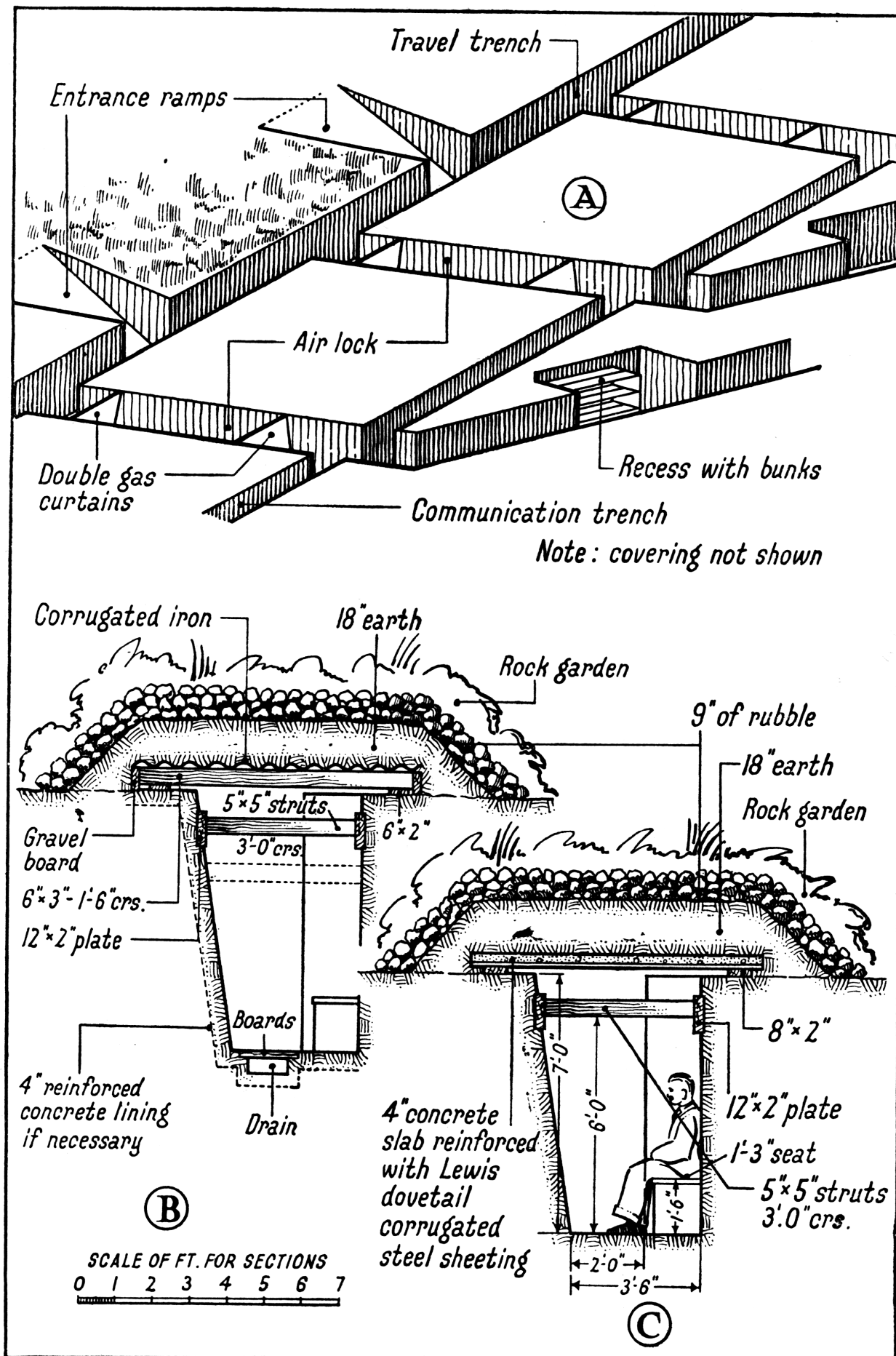


FIG. 72.—Showing (A) entrance to trench system Fig. 71.
(B) and (C) alternative sections.

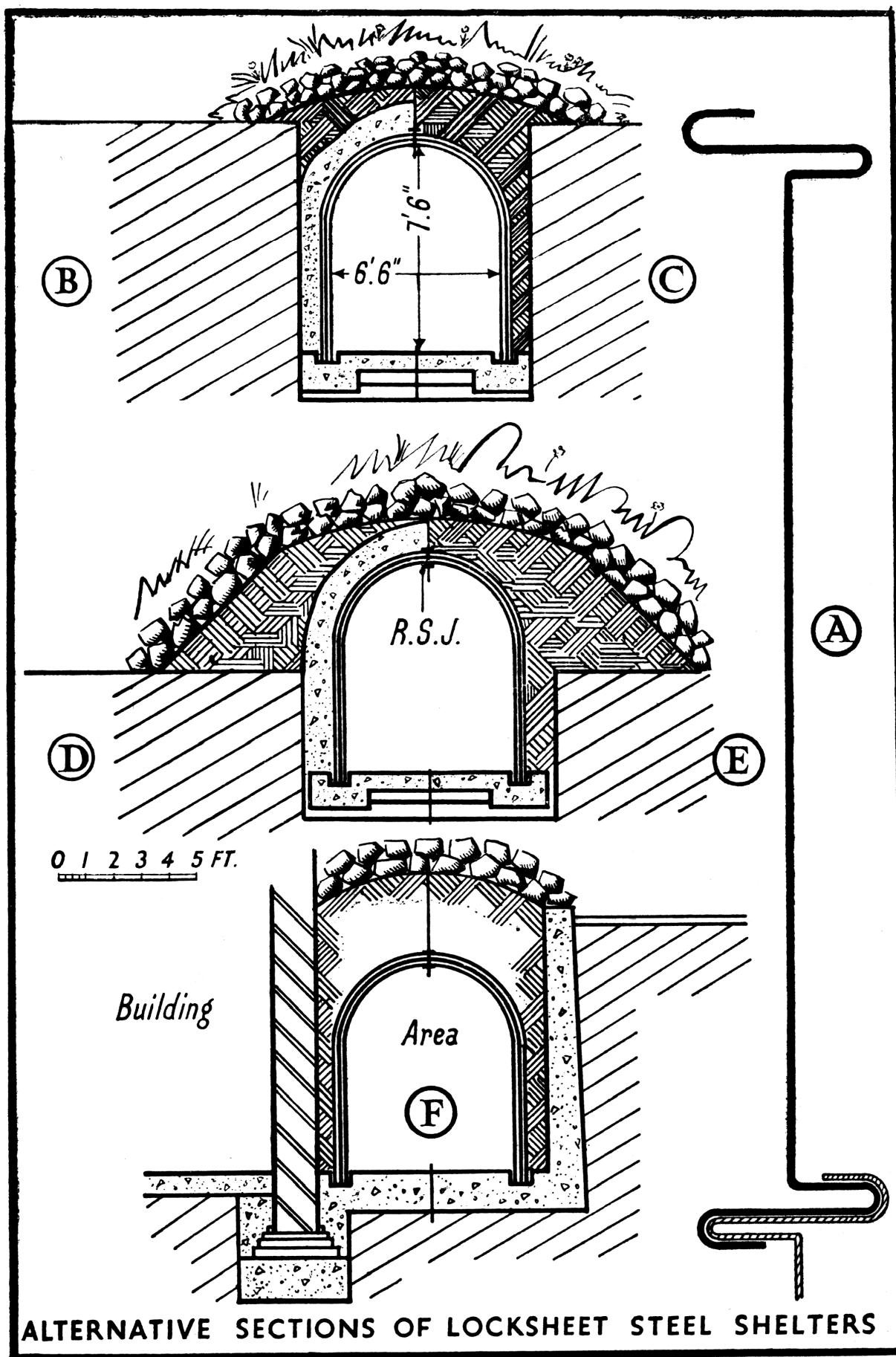


FIG. 77.—Costain's locksheet steel shelters. A, enlarged section of locksheet steel; B, constructed in deep trench and covered with concrete, earth and rubble; C, constructed in deep trench and covered with earth and rubble; D and E, partly underground, and F, in area of building.

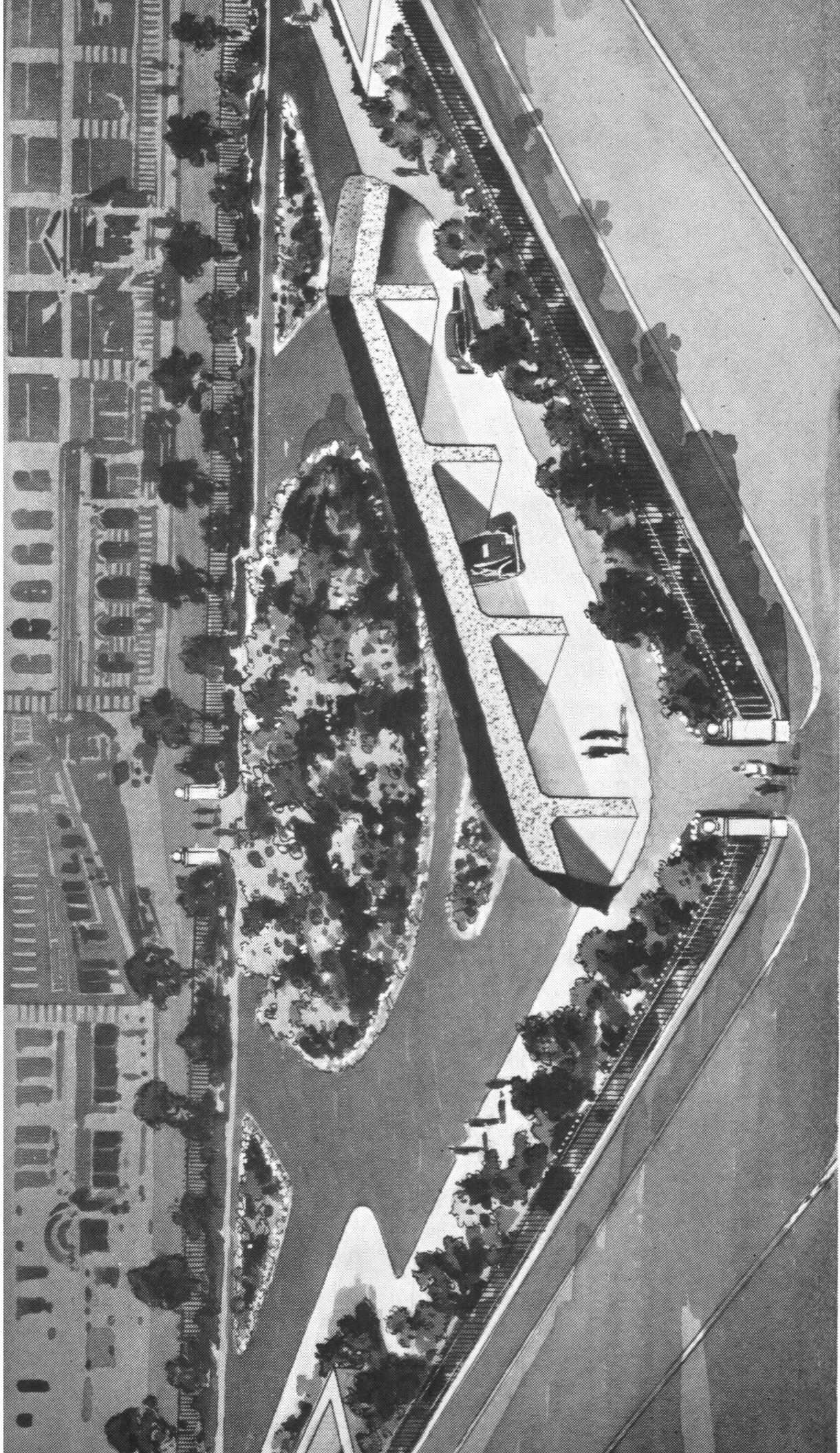


FIG. 88.—Garage under public gardens providing the much needed peace-time accommodation for cars and shelter for the floating population in an air raid.

before and after evacuation. It would therefore appear that allowing for a certain necessary amount of duplication of shelter accommodation, provision should be made ultimately for the following protection :—

TABLE LI

	Population.	Cost per capita.	Total cost.
<i>Principal danger zones</i> requiring shelters proof against heavy bombs (Allowing for 33½ per cent. additional accommodation for use before evacuation.)	4,000,000	£30	£120,000,000
<i>Medium danger zones</i> requiring shelters proof against small bombs	20,000,000	£10	£200,000,000
<i>Outskirts of towns</i> requiring splinter-proof protection (Allowing 14 per cent. additional accommodation.)	8,000,000	£5	£40,000,000
<i>Rural districts</i> requiring no special protection	15,000,000	—	—
TOTAL POPULATION FOR WHICH SHELTER ACCOMMODATION IS NEEDED .	32,000,000		£360,000,000

It is probable that a fair percentage of shelters, especially of the light bomb and splinter-proof type, can be provided by the adaptation of existing premises, thus reducing materially the total cost of new work. Against this saving has to be set the costs of transportation, temporary housing and general provisioning of the evacuated population.

On the whole, therefore, a total national expenditure approximating 300 millions sterling will be incurred in the adequate passive defence of the civil population of the British Isles.

That this expenditure shall be as productive as possible it will be necessary to ensure that the highest possible proportion of shelters are constructed for the dual purpose of some peacetime use and the assurance of protection in emergency:

Public money will be expended as well as a great deal of private money, but the very nature of the construction will render shelters less vulnerable than ordinary buildings in air

A peace-time utilisation of an air-raid shelter might therefore render the " addition or improvement " liable to taxation.

EVACUATION

Evacuation necessarily forms an important part of any general scheme for passive defence and the French plans are worthy of consideration.

In 1936 the French Government issued a handbook on evacuation, and the following extracts and notes are of interest.

There is no doubt that the orderly and methodical execution, at the time of need, of a plan of evacuation which has been carefully prepared in every detail during peace time is calculated to save a great number of human lives. Such a result makes it worth while to make every effort to prepare such a plan, in spite of all difficulties that may be encountered. The general scheme proposed by the French handbook recommends :—

- " (1) All persons who will leave the town voluntarily should be encouraged to do so.
- " (2) Permanent evacuation of the people unimportant from the military or administrative point of view into the country districts.
- " (3) Evacuation of people whose relatives must remain in the town, to places nearby.
- " (4) Nightly evacuation of people who must work in the town.
- " (5) Shelters to be provided for all people who must remain in the town.

" These plans must be formulated by the mayor of the town, and he must arrange with the local authorities of the villages how many refugees each village can accommodate. The order for evacuation will be given by the Government before they issue the order for the mobilisation of the armed forces.

" It is proposed that each person should have an evacuation ticket at the outbreak of a war and these tickets are already printed.

" Such a ticket would read as follows :—

" " Mr. X. is instructed to take the 8 p.m. train this evening from the Gard du Nord for Amiens. He is to take

with him his wife and four children, travelling in seats Nos. 37-42 inclusive.' "

In this country detailed arrangements are not yet disclosed but Sir Samuel Hoare, in the House of Commons on June 1st, 1938, explained that time-tables had been worked out to move 3,500,000 people by rail fifty miles from London in seventy-two hours, without train tickets. Evacuation is obviously a more effective passive measure than the provision of shelter accommodation but complete evacuation is not possible.

It would probably be safe to assume that all children under the school-leaving age, babies and their mothers, old people and invalids, amounting to about 25 per cent. of the urban population, could be permanently evacuated to areas requiring no special protective measures.

All specially dangerous locations might also be vacated except for a permanent cadre of key men, thus possibly accounting for another 10 per cent. of the population.

The central zones of cities and areas near military objectives would need the highest degree of protection and the outskirts splinter-proof protection.

The difficulties attendant upon evacuation would cause delays in its execution and it would therefore be necessary to provide shelter protection on a crush capacity basis for larger numbers at the outset.

It would consequently appear that the distribution of the urban population would be adjusted in an emergency somewhat on the lines indicated below:—

TABLE LII

APPROXIMATE DAY-TIME DISTRIBUTION OF URBAN POPULATION

	Before evacuation.	After evacuation.
Principal danger zones .	13,000,000	3,000,000
Medium danger zones .	22,000,000	20,000,000
Outskirts of towns . .	10,000,000	7,000,000
Rural districts . .	Nil	15,000,000
Totals . .	45,000,000	45,000,000